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farther than this and venture to say that the energy evolved in muscular contraction, that also involved in secretion and excretion, the force concerned in the phenomena of nuclear and cell division, and that force also engaged by the nerve cell in the production of a nerve impulse are but manifestations of surface tension. On this view the living cell is but a machine, an engine, for transforming potential into kinetic and other forms of energy, through or by changes in its surface energy.

To present an ample defence of all the parts of the thesis just advanced is more than I propose to do in this address. That would take more time than is customarily allowed on such an occasion, and I have, in consequence, decided to confine my observations to outlines of the points as specified.

It is not a new view that surface tension is the source of the muscular contraction. As already stated, the first to apply the explanation of this force as a factor in cellular movement was Engelmann in 1869, who advanced the view that those changes in shape in cells which are classed as contractile are all due to that force which is concerned in the rounding of a drop of fluid. The same view was expressed by Rindfleisch in 1880, and by Berthold in 1886, who explained the protoplasmic streaming in cells as arising in local changes of surface tension between the fluid plasma and the cell sap, but he held that the movement and streaming of *Amœbæ* and *Plasmodiæ* are not to be referred to the same causes as operate in the protoplasmic streaming in plant cells. Quincke in 1888 applied the principle of surface tension in explaining all protoplasmic movement. In his view the force operates, as in the distribution of a drop of oil on water, in spreading protoplasm, which contains oils and soaps, over surfaces in which the tension is greater, and as

soap is constantly being formed, the layer containing it, having a low tension on the surface in contact with water, will as constantly keep moving, and as a result pull the protoplasm with it. The movement of the latter thus generated will be continuous and constitute protoplasmic streaming. In a similar way Bütschli explains the movement of a drop of soap emulsion, the layer of soap at a point on the surface of the spherule dissolving in the water and causing there a low tension and a streaming of the water from that point over the surface of the drop. This produces a corresponding movement in the drop at its periphery and a return central or axial stream directed to the point on the surface where the solution of the soap occurred and where now a protrusion of the mass takes place resembling a pseudopodium. In this manner, Bütschli holds, the contractile movements of *Amœbæ* are brought about. In these the chylema or fluid of the foam-like structure in the protoplasm is alkaline, it contains fatty acids and, in consequence, soaps are present which, through rupture of the superficial vesicles of the foam-like structure at a point, are discharged on the free surface and produce there the diminution of surface tension that calls forth currents, internal and external, like those which occur in the case of the drop of oil emulsion.

A. B. MACALLUM

(*To be continued*)

#### METEOROLOGY AT THE SHEFFIELD MEETING OF THE BRITISH ASSOCIATION

THE work on meteorology for the British Association for the Advancement of Science is organized under Section A—Mathematical and Physical Science—and under the subsection (*b*) Cosmical Physics and Astronomy. There can be no more pronounced recognition of the opinion that meteorology has already made good its claim to be considered as a subordinate branch of solar and cosmical physics,

due to the fact that the temporary physical state of the earth's atmosphere is what it is at any point in consequence of the effects of solar radiation in the earth's circulating atmosphere. This subject has developed so many difficult problems in the relations of temperature distribution to local absorption and emission of radiant energy, of radiation to ionization, atmospheric electricity and magnetism and of heat energy to general and local circulation, that the best resources of astronomers, physicists and mathematicians are called upon for their solution. The extent and range of these complex subjects, and the number of able scientists who are interested in them, is making a demand that meteorology shall be recognized as an independent section of the British Association for the Advancement of Science. This question is receiving the careful consideration of the council, and the several conflicting claims will be weighed, with the present probability that the new section will be established.

The meeting of September 6 was opened by a discussion of the status of the problems of atmospheric electricity, being a résumé of the practical aspect of the theory and the apparatus, by Dr. Charles Chree, superintendent of the Kew Magnetic Observatory. The Thomson water-dropping apparatus for the electrical potential has been recently so far improved that the average gradient in volts per meter has risen from 200 to 300 in many cases. The Elster and Geitel apparatus for dissipation of electric charges, and the conductivity of the air, is still vitiated by the difficulty of saturated fields around the charged body. The Ebert ion-counter does not clear the passing current of air of all the contained ions. In short, the work of arriving at any absolute standard instruments is still very considerable. Sir Oliver Lodge followed with an account of Lemström's application of static electricity to the growth of plants, as indicated by experiments in England, and fully recommended further investigations. Professor J. J. Thomson discussed the very high tension electricity in the atmosphere as exhibited in thunder storms, and preferred to refer it to the action of con-

vection currents. Dr. W. N. Shaw gave an interesting account of several meteorological problems along these lines. The consensus of opinion is clear that this entire range of problems requires much more work of investigation in every possible way before any conclusion of a definitive sort will be possible.

The individual papers were as follows:

Dr. W. Schmidt, of Vienna, described an apparatus for measuring the short waves of the barometric pressure, as where a warm current overflows a cold current, after the analogy of Helmholtz's long waves, and fully illustrated the subject by an application to the local conditions at Innsbruck.

Mr. W. H. Dines exhibited his instrument for the simultaneous self-recording of the pressure and temperature of the air at all elevations reached by balloons. It is very light, weighing only a few ounces, and makes the record without magnification on a small plate, to be read under a microscope at leisure. He showed his records and pointed out that observations made in sunshine are so much affected by radiation that soundings should be carried on at night, in order to avoid the loop in the ascending and descending branches.

Dr. J. W. Nicholson developed a method of studying the effects of radiation pressure on small particles of different sizes, together with the necessary criteria for application to the forms of comets' tails.

Miss M. White, of Manchester, gave the results of a remarkable set of ascensions made in March, 1910. It seems that twenty-eight balloons were sent up in a single 24-hour interval, and the combined records were exhibited. These small balloons, costing about five dollars each, equipped with Dine's instruments, penetrated to about 20,000 meters, and they showed the lower level of the isothermal layer to have been at about 11,000 meters in height. Such perfectly definite measures of temperature are of course very valuable because from them the pressure, density and gas coefficient can be computed, and many important conclusions depend upon these facts. No expensive observatory establishment is necessary for such work, and similar observations ought to be made in all parts of the world.

Mr. R. F. Stupart, director of the Canadian Service, showed that temperature inversion effects occur in Alberta, similar to those previously found by Bigelow over the Rocky Mountain region in the northwestern states, showing that the warming adiabatic currents flow as a sheet eastward over the mountains for many hundred miles in a north-and-south line, from northern Alberta to Colorado.

Mr. E. Gold gave a paper with summary regarding the effects of radiation on the height and temperature of the isothermal layer over cyclones, anticyclones, in the tropics and the temperate zones generally. The interrelations of this complex problem were briefly considered, the result being that many more observations are needed, especially in the tropics.

Professor F. G. Baily exhibited diagrams and models of a sensitive seismograph, being an extension of a vertical bifilar system, the mirror being suspended from a bifilar hanging on a bifilar. The records are promising and the instrument is not heavy or bulky.

All the papers were of an excellent quality, and the discussions, though limited for lack of time, were intelligent, showing that these subjects are of primary interest in England.

There are other matters of importance just now occurring, under the able administration of Dr. W. N. Shaw, in the British Meteorological Service. The old office in Victoria Street, London, is being removed to South Kensington, for the sake of enlarged quarters, and the personnel of the service is being strengthened. The Kew Magnetic Observatory, Dr. C. Chree, director, long an independent and well-known institution for magnetic work, has been amalgamated with the Meteorological Office, and they now form one service. This office is also in close touch with the South Kensington Solar Physical Observatory, Sir Norman Lockyer, director, so that the allied branches of solar physics, atmospheric electricity and magnetism, meteorological records and forecasting, are acting in close harmony. This would be like uniting the astrophysical observatory of the Smithsonian Institution, the magnetic department of the Carnegie Institution so far as it relates to atmospheric phenomena, and the Weather Bureau, a policy

which I think should be advocated until it has been accomplished. There is great scientific disadvantage in carrying on these lines of research independently, and it should be remedied before large masses of valuable observations accumulate. Mr. Stupart informs me that the Canadian government is establishing, in connection with the magnetic observatory at Agincourt, about ten miles from Toronto, a fully equipped institution for balloon and kite work, for atmospheric electricity in all its relations to ionization, and for solar radiation. The balloon work will be valuable in supplementing the Mt. Weather work on cyclones and anticyclones, because the location of the southern station is such that the great majority of the storms run to the northward of it, so that the data are over-abundant in the southern and scanty in the northern quadrants, and make a difficult distribution of material for any important discussions. I am also informed that the Argentine government is making large extensions of their service along similar lines of general physics. Since it is necessary that meteorology should be carried on by governments with considerable resources, on account of the necessity in forecasting of an elaborate organization for collecting data promptly, it follows that they at the same time assume the responsibility for the maintenance of researches tending to improve the service for the public utility.

Meteorology is a difficult subject, and it requires unusual effort and expenditure of money to make any important progress. It is evident, however, that scientists in all parts of the world are in agreement with the policies pursued by the three governments just mentioned as the most practical way of attacking the great problems in question.

FRANK H. BIGELOW

SHEFFIELD, ENG.,

September 7, 1910

*THE TENTH ANNUAL NEW ENGLAND  
INTERCOLLEGIATE GEOLOGICAL  
EXCURSION*

THE party will assemble late Friday afternoon, October 21, at the Hanover Inn, Hanover, N. H. After supper there will be a preparatory meeting, at which short expositions